ELECT STANDARDS LAB
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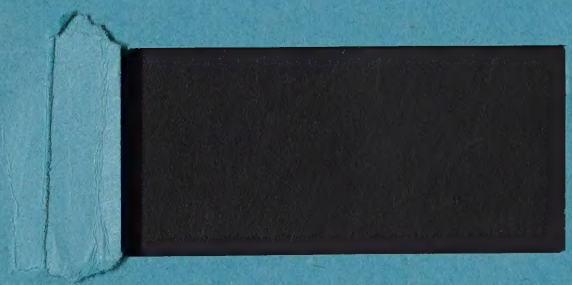
INSTRUCTION BOOK

MP MASTER
MA23355



UNIVERSAL COUNTER-TIMER

TYPE TM51.

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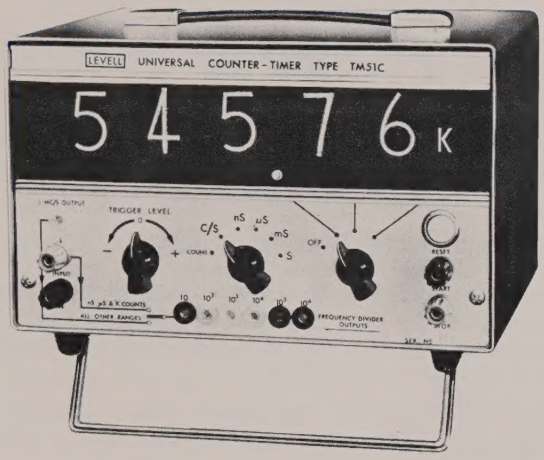
UNIVERSAL COUNTER-TIMERS

TYPES TM51B and TM51C



These transistorised portable digital counting instruments measure frequency and time interval over the ranges 1c/s to at least **6**Mc/s and 3μs to 27.77 hours with the utmost simplicity of operation. The two versions differ only in the stability of the internal 1Mc/s crystal reference standard.

Leading features of these instruments are: High sensitivity of 35mV at frequencies up to **3**00kc/s; Top counting frequency above **6**Mc/s; Low input noise level to minimise trigger error on period measurement; Display storage to minimise operator fatigue.

The counter has five decades operating on a 1-2-4-8 code and the in-line display is on five long-life neon numerical indicating tubes. The display is controlled by a latching circuit which holds the display stationary whilst a count is in progress and automatically resets the display at the completion of a count. This feature dispenses with the need for hold controls or display blanking and ensures a high sampling rate down to very low frequencies.

The instrument function is selected by two rotary switches; one marked in the quantity to be measured (c/s, ns, μs, ms, s and Count), and the other selecting the position of the illuminated decimal point. The letter "K" is illuminated on the appropriate frequency and count ranges indicating kilo-units.

The usefulness of the instrument as a counter is extended from 10^5 counts to 10^7 counts by the kilo-count ranges on which every tenth or hundredth input pulse is displayed. On "Count" operation, the counter is controlled by pulses applied to "Start" and "Stop" terminals.

Provision is made for an external frequency standard to be used in place of the internal 1Mc/s crystal oscillator. Pulse outputs are available on the front panel at decade divisions of either the internal 1Mc/s oscillator or the input trigger frequency, thus the instrument may be used as a frequency divider up to 1Mc/s.

SPECIFICATION OF TYPES TM51B and TM51C

FREQUENCY RANGES

1c/s to at least **6**Mc/s measured on 3 ranges with gate times of 10ms, 100ms and 1 second.
Accuracy: $\pm$ 1 count $\pm$ crystal error.

TIME RANGES

3μs to 27.77 hours measured on 7 ranges in units of 1μs, 10μs, 100μs . . . 1 second.
Accuracy: $\pm$1 count $\pm$ crystal error $\pm$ trigger error.

PERIOD AVERAGE RANGES

10, 10^2 . . . 10^5 input periods measured in units of 1μs on 5 ranges.
Accuracy : ± 1 count ± crystal error ± trigger error/number of periods.

1Mc/s CRYSTAL ERROR

TM51B : ±0.001% at 20°C after 1 minute. Ageing 2 parts in 10^8/week.
±0.003% from −10°C to +45°C after 1 minute.
TM51C : ±0.0001% at 20°C after 20 minutes. Ageing 3 parts in 10^7/month.
±0.0003% from −10°C to +45°C after 20 minutes.

TRIGGER ERROR

Any trigger circuit operated by a sinusoidal signal of amplitude S in the presence of noise N is subject to a trigger error of ±0.3N/S.
The input trigger circuit has an equivalent input noise of less than 300μV r.m.s. thus for 100mV r.m.s. input the trigger error is ±0.1%.
Trigger error is inversely proportional to the slope of the input at the trigger point so that the error is reduced by increasing the amplitude of a sinusoidal input or by using a pulse input.

COUNT RANGES

10^5 counts with every count displayed; absolutely accurate. Maximum speed 6Mp/s.
10^6 counts with every 10th count displayed; accuracy ±9 counts. Maximum speed 1Mp/s.
10^7 counts with every 100th count displayed; accuracy ±99 counts. Maximum speed 1Mp/s.

TRIGGER INPUT SENSITIVITY

35mV r.m.s. on sine waves from 0 to 300 kc/s, decreasing to 100mV at 3Mc/s and 300mV at 6Mc/s. Maximum safe input 250V r.m.s.

TRIGGER INPUT IMPEDANCE

100 kilohms in parallel with 10pF.

TRIGGER LEVEL & SLOPE

The trigger level is continuously variable from −750mV to +750mV with a stability of 100mV throughout the temperature range −10°C to +45°C. The operative trigger points are where the input signal passes through the trigger level with positive slope.

START/STOP INPUTS FOR COUNT RANGES

Positive pulses of amplitude between 3 and 10 volts with rise rate greater than 1V/μs and duration longer than 1.5μs.
The input impedance of the start and stop terminals is 500pF.

EXTERNAL STANDARD INPUT

Frequencies between 1kc/s and 1Mc/s can be injected in place of the internal 1Mc/s reference standard through a miniature jack socket on the rear panel.
Amplitude should be between 1V and 5V r.m.s.
Input impedance is 700 ohms.

REFERENCE STANDARD OUTPUT

Square wave of amplitude 750mV peak to peak with a source impedance of 50 ohms.

FREQUENCY DIVIDER OUTPUTS

On the ns, μs and the kilo-count ranges the 6 divider outputs are at 10^{-1}, 10^{-2}, . . . 10^{-6} times the trigger input frequency at frequencies up to 1Mc/s.
On all other ranges the 6 divider outputs are at 100kc/s, 10kc/s . . . 1c/s, or, at decade divisions of an external standard input.
The outputs are positive pulses of amplitude 3V and source impedance 600 ohms in series with 500 pF.

DISPLAY

5 digits on long life neon numerical indicating tubes with 3cm character size and wide viewing angle.
Display storage exists on the frequency, time and period average ranges.
The display is latched to the output of the counter during a 100ms sampling period at the end of each count.

TEMPERATURE RANGE

−10°C to +45°C.

POWER SUPPLY

100/125V or 200/250V, 45/65 c/s, 25 VA.

SIZE AND WEIGHT

6½″ high x 10¼″ wide x 9″ deep (16.5 cm x 26 cm x 23 cm). 11 lbs. (5 kg).

LEVELL ELECTRONICS LTD., PARK ROAD, HIGH BARNET, HERTS., ENGLAND

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Printed in England

1. Connection to an A.C. Mains Supply.

The mains voltage selector must be set to suit the voltage of the A.C. mains supply. This selector will be found on the rear panel of the instrument. The position marked 230 covers supplies between 200 and 250 volts whereas the position marked 115 covers supplies between 100 and 125 volts.

The supply leads are normally colour coded in accordance with the British convention, Red Live, Black Neutral, and Green Earth. Exported instruments may, however, be wired to suit the coding convention of the country to which they are exported. In case of doubt, check that the earth connection is made to the lead that is joined to the case of the instrument.

2. To Measure Frequency.

Connect the unknown frequency to the input of the instrument and select "c/s" on the centre control. Turn the right hand control to one of the three frequency ranges and observe the display after allowing two seconds for the count to be registered. The letter "K" will be seen to glow on two of the frequency ranges indicating that the reading on these ranges is in units of Kc/s with the decimal point as shown by the glow of one of the decimal point indicators.

The indication of zero reading on the display means that the input signal is failing to operate the counter input trigger circuit. The input terminal is D.C. coupled to this trigger circuit through a wideband amplifier, and the "Trigger Level" control is used to vary the trigger level throughout the limits given in the specification. When the input signal is superimposed on a D.C. voltage, there is the possibility that the input voltage does not pass through the range of the Trigger Level control. The input must then be attenuated, or, the D.C. component must be removed by inserting a capacitor in series with the input.

The setting of the Trigger Level control is critical when the input signal is low in amplitude and difficulty may be experienced in finding the correct setting as the display does not change instantaneously when the control is varied.

The procedure to adopt in this case is to turn the right hand control fully clockwise and select "Count" on the centre control. The display will then change every time the input trigger circuit is fired and selection of the correct position of the Trigger Level control is relatively simple.

The indication of high or erratic readings indicates that high frequencies are entering the input of the Universal Counter-Timer in addition to the frequency that is to be measured. This is likely to arise when the instrument is used in the vicinity of a powerful radio station that is operating at a frequency within the wide frequency range of the counter. The solution to this problem is to screen or filter the input leads to the instrument.

3. To Measure Periods.

Connect the input signal and adjust the Trigger Level control as already described. Select a suitable time range by adjustment of the two rotary switches. Allow a time equal to two periods to elapse before observing the display. It is important to realise that two erroneous indications can occur before the display indicates the true period of the signal under test. The first indication is that giving the state of the counter at the instant of switching to the time range. The second erroneous indication is the count which occurs between the instant of switching to the time range and the first positive going traversal of the trigger level by the input signal.

A fundamental difficulty is encountered when the period of a sinusoidal signal of small amplitude is measured by a Counter-Timer. Noise inherent in the input signal and the input circuit of the instrument causes a trigger error which may well be the most predominant error in the method of measurement. It can be shown that the possible error is $\pm$ C.3 N/S where S/N is the signal to total noise ratio of the sinusoidal input. Thus for a signal to noise ratio of 40dB, the possible error in a single period measurement is $\pm$ C.3% and to measure to an accuracy of $\pm$ C.C03% demands a signal to noise ratio of 80dB. Total noise voltage in the counter input circuit of 1mV would thus cause a possible trigger error of $\pm$ C.3% for 100mV input and $\pm$ C.C03% for 10V input. The error in a period measurement can be reduced by averaging the readings which occur over a number of measurements since the error is a random variation about the true period. The error can be further reduced by measurement over 10 or 100 periods of the input signal by use of the first

two ranges on the Decimal Point switch when "µs" is selected on the function switch. Measurement over 10^3, 10^4 or 10^5 input periods is made when "ns" is selected on the function switch. The trigger error due to noise is then reduced in proportion to the number of periods that are measured.

4. To Count Pulses

The instrument is controlled on the "Count" ranges by signals applied to the "Start/Stop" terminals. The application of a positive pulse to the start terminal opens a gate that is present between the input trigger circuit and the counting stages. The application of a following positive pulse to the stop terminal closes this gate and leaves the display registering the state of the counter at the instant of application of the Stop signal.

The gate may be either open or closed when "Count" is selected so a positive pulse must be applied to the start terminal to open the gate. Touching the start terminal with a screwdriver held by hand will usually provide sufficient impulse to open the gate.

The input trigger circuit is operated every time the trigger level is traversed by the input in a positive going direction. The counting stages are operated either every time the trigger circuit operates or every 10th or 100th time according to the position of the decimal point switch. The letter "K" will be seen to glow on the two ranges in which the trigger signal is passed through the decade divider circuits so that the display shows the number of Kilocounts with the decimal point as indicated by the position of the Decimal Point switch.

It should be noted that the counter retains its last state whilst the gate is closed so that the sum total of events during the open periods is displayed. The counter can be reset to zero at any instant by operation of the Reset button.

5. To Check the Counting and Dividing Circuits

Connect the input to the 1 Mc/s output socket and check that the reading is correct on all three frequency ranges to within $\pm$ 1 count. Repeat the check with the input connected to the 10 kc/s output socket.

6. To Use an External Time Standard

The internal 1Mc/s reference oscillator is connected to a squaring circuit through a miniature jack socket that is located on the rear panel of the instrument. The insertion of a plug into this socket, automatically disconnects the 1Mc/s oscillator and feeds the external signal directly into the squaring circuit.

7. To Use the Output Sockets

The output sockets on the front panel give pulses at decade divisions of either the 1Mc/s reference oscillator or the input trigger circuit pulses. The output pulses may be fed into a low impedance circuit or a mixing resistance network without fear of affecting the operation of the normal ranges of the instrument. Care should, however, be taken to ensure that external pulses, of amplitude in excess of a volt, are not fed into these output sockets.

8. To Adjust Preset Zero Control

This control is located on the Logic Circuit Board which is the lowest circuit board in the instrument. To adjust this control turn the trigger level control to zero and feed in a sinusoidal signal at a frequency of 1kc/s with an external variable amplitude control. Reduce the amplitude of the signal to the minimum to maintain stable triggering of the counter. Adjust the preset zero control and reduce the output of the signal generator until the preset control is set at that value which permits stable triggering with the least output from the signal generator.

G U A R A N T E E

We undertake to repair, or replace free of charge, any components that fail in this instrument within 12 months from date of purchase, provided that,

(a) the guarantee card is posted within 14 days of purchase and
(b) the instrument is not, in our opinion, modified or misused.

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